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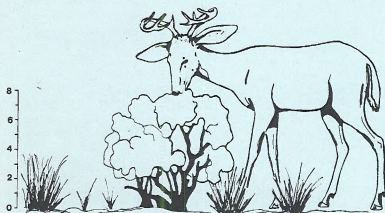
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IDAHO BLM

TECHNICAL BULLETIN

RESTORING WINTER GAME RANGES
IN SOUTHERN IDAHO



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Technical Bulletin 86-3

June 1986



QL
84.2
.L352
no. 86-3

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Idaho State Office
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Boise, Idaho 83706

#13143839

ID: 88006576

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I. BACKGROUND

Wildfires are part of many rangeland environments throughout the West. However, with the introduction of cheatgrass to rangelands in poor condition at the turn of the nineteenth century, the frequency and size of wildfires have increased in southern Idaho. It is estimated that the fire hazard on sagebrush ranges has increased several hundred times by their conversion to cheatgrass ranges (Tisdale and others, 1969). In 1985 alone, wildfires burned over 240,000 acres in southwestern Idaho and the acreage burned each year has averaged more than 200,000 acres over the past ten years (unpublished report, BLM, Idaho State Office, 1985). Some areas have burned seven times during the past nine years (unpublished report, BLM, Boise District, fire records 1985).

The reoccurrence of wildfires on the same area, coupled with the burning of adjacent, previously unburned native vegetation, is changing rangeland characteristics in southern Idaho. Perennial grasses, bitterbrush, sagebrush, broadleaf herbs, and other desirable perennial browse plants are being eliminated from relatively large areas (some burns are 20,000+ acres in size). The major impacts from these fires are accelerated loss of soil, wildlife habitat, and perennial grasses. Sagebrush and other shrubs are an extremely important component of wildlife habitat. In many instances, because of the frequency of burns over the same area, no natural seed source exists for several miles for the re-establishment of shrubs after wildfires. Often, rehabilitated burns are seeded only with grasses, which can competitively exclude shrubs from returning to the site.

The importance of shrubs to wildlife is widely recognized. Besides providing food, shrubs supply necessary cover where wildlife can escape predators, rear young, and ward off the physical elements.

Studies on winter ranges have stressed the importance of browse and shrub diversity in providing game animals with a balanced diet. Loss of diversity caused by overgrazing and destruction of the preferred forage species can result in big-game herd losses. Winter losses of mule deer in Utah were related to available browse and particularly that of the preferred species (Robinette and others, 1952). One area no longer supporting any preferred browse, suffered a 40% animal loss during a severe winter, compared with only a 10% loss for an area that had an adequate browse cover.

A deer's vigor during the crucial winter months in colder regions depends on its energy budget. The food consumed must compensate in part for the energy lost as body heat due to chilling weather, as well as that expended in struggling through deep snow in search of forage. A negative energy balance develops when the available browse is comparatively indigestible or in short supply. Consequently, deer must then call upon their stored fat reserves to stay alive. Shrubs also provide thermal cover which shelters the deer from cold temperatures.

Some range plants supply certain winter nutrients below the level needed by the consuming animal (Urness, 1980). In general, three nutrients are in short supply in winter forages (Dietz, 1965). These nutrients are energy (TDN), protein, and phosphorus. Four-wing saltbush, winterfat, big sagebrush, and curleaf mahogany (all evergreen shrubs) exceed the digestible protein requirement. Dormant grasses, needle-and-thread, western wheat grass, and Indian ricegrass are lower in digestible protein than deciduous shrubs. In general, shrubs are higher in winter levels of digestible proteins and phosphorous than are grasses (Cook, 1972, Welch, 1981). Also, most evergreen shrubs have even higher levels of digestible protein and TDN in the winter than do deciduous shrubs (Welch, 1981).

Big sagebrush (*Artemesia tridentata*) is the single most important food for wintering mule deer in Utah, Nevada, parts of Idaho, Colorado, Wyoming, and California (Leach, 1956; Kufeld and others, 1973; Tueller, 1979). The average winter diet of mule deer contains from 40 to 60% big sagebrush. During periods of deep or crusted snow cover, mule deer may rely on sagebrush browse exclusively. Other wildlife species also depend heavily on big sagebrush as a food item. These species include sage grouse, pronghorn antelope, and pygmy rabbits (McArthur and others, 1979). Sagebrush also has value as a cover plant for wildlife and as a soil stabilizer. Shrub species are often planted on disturbed sites, such as on mine spoils, to improve wildlife habitat and reduce erosion.

Shrub species are important to the diet of domestic livestock. Wintering domestic sheep may consume two to three pounds of big sagebrush per day, which was 50 to 60% of their diet (Blaisdell and others, 1982). Shrubs having lower palatability are generally grazed most heavily in winter or under severe stress conditions (Merrill, 1972). Cattle are commonly forced to utilize big sagebrush in regions with long, cold winters. While in the summer, under moderate grazing pressure, shrubs can still comprise 10-16% of a cow's diet (Halls and others, 1957). On ranges where saltbushes occur, they are important producers of nutritious forage for game and domestic livestock (Gates and others, 1956). Some ranchers have operated profitable cow-calf operations on shrub ranges (Zimmerman, 1980).

Diverse vegetative cover is important in every plant community and, in southern Idaho, vegetative cover should include shrubs and forbs as well as grasses. It is important that the herbaceous understory consists of a complement of species that can not only prevent or control the invasion of cheatgrass, but will allow the reestablishment and natural regeneration of native shrubs. A shrub, forb, and grass association will provide a diverse habitat for many species of wildlife as well as livestock (DePuit and Coenenburg, 1979). Shrubs are important in many ways to both animal and plant communities. The various functions shrubs provide include: 1) substantial herbage production, hence providing forage and cover for wildlife and livestock; 2) niche diversification; and 3) general cover for effective soil stabilization (Robinette, 1972; Valentine, 1970; Plummer and others, 1968). Shrubs' deeper roots prevent erosion and recycle minerals from deep in the soil back to the surface (Murray, 1976). Also, the deep-rooted nature of shrubs cause them to be a more dependable food source during drought (Welch, 1986).

The use of shrubs for soil cover and stabilization automatically involves and benefits much more.

Shrub cover decreases the wind speed on the ground and acts as snow fences in the winter. Shrub stands in the cold desert of southern Idaho often have greater effective soil moisture due to the snow-fencing effect and lower wind speeds decreasing surface evaporation. Such shrub stands also exhibit higher species and microclimatic site diversity.

Although shrubs protect soil movement from the forces of wind and water, it should be noted that shrubs species alone do not form a complete cover of an area. Grasses and forbs must also be used to supplement the shrub cover. Broadleaf herbs and grasses are important winter, spring, and fall herbage in southern Idaho. Many ranges are free of deep snow cover and winter temperatures allow many herbs to maintain green growth throughout much of the fall, winter, and spring periods. Many areas in southern Idaho are also vital as spring-fall ranges. Although these sites are obvious important winter ranges, their value as spring-fall ranges must be recognized. Species adapted to these vast areas normally grow during the spring-fall periods. Management of these sites must recognize climatic factors that regulate plant growth. The vegetative diversity of a site improves its ecological condition and increases its stability.

Shrubs add structure and depth to landscapes which smooth out gullies and colors mosaic patterns to the distant horizons. The sagebrush-grass rangeland can be interesting and beautiful when seen as an important watershed, a producer of livestock, and a valuable wildlife habitat. To some people, the ultimate in outdoor enjoyment is viewing a deer or antelope in its native habitat, or a coyote slinking across an opening in the sagebrush.

In summary, shrubs are beneficial for:

1. forage,
2. soil stability,
3. increasing community diversity and stability,
4. consistent annual biomass,
5. mineral cycling,
6. thermal and escape cover for wildlife,
7. snow fencing, and
8. aesthetics.

II. SHRUBS SUITABLE FOR SOUTHERN IDAHO

Shrubs suitable for restoring the winter range in southern Idaho need to be drought tolerant, competitive, and persistent. Some species should be palatable, yet the structural configuration alone of shrubs is beneficial for thermal cover, snow fencing, and increasing the community diversity. Palatable shrubs should supply wintering animals with energy, protein, and phosphorus, which are the nutrients in the shortest supply during the winter season (Welch, 1983). Animals carry winter fat to burn for energy, but lack a source of protein for the production of enzymes and other metabolic requirements. Therefore, digestible protein content should be a major consideration in selecting winter forage plants.

Dormant grasses are lower in digestible proteins than are deciduous shrubs (Welch, 1983). Evergreen shrubs, such as sagebrush, are higher yet in digestible protein. This fact, along with the depth of snow cover, makes shrubs the key food item in winter. Shrubs become the only food source when the snow pack is deep or hard crusted. Such stressful conditions rather than the average conditions are the limiting or controlling factors on animal population numbers.

Palatability is influenced by the fiber, moisture, protein, and chemical content as well as the plants' texture. Species, subspecies, varieties, ecotypes, and races of plants may differ slightly or greatly in any of these above features to produce more or less palatable plants. Therefore, a slight chemical difference between two apparently similar sagebrush plants greatly affects their palatability. Chemicals such as asprotein or the volatile odors one associates with sagebrush plants, change with the seasons. Shrubs heavily laden with volatiles in the summer may contain lower concentrations in the winter or spring (McArthur and others, 1979).

So, what shrub species should be selected for revegetating winter ranges in southern Idaho?

Several native shrubs satisfy the above requirements for winter range suitability. Wyoming sagebrush, bitterbrush, fourwing saltbrush, winterfat, and rabbitbrush are among those best suited. Table #1 lists these and several other shrub species suitable for planting on winter ranges.

Locally adapted ecotypes from similar habitats should be chosen for sources of propagation. Also, more highly palatable varieties of these species could be tested and propagated in suitable sites.

For example, Hobble Creek Sagebrush is a highly palatable race of Mountain Big Sagebrush developed in Utah. It is greatly preferred by deer and domestic sheep. It can be outplanted in well-drained loamy soils with 14+ inches of precipitation. Several superior cultivars of big sagebrush are being developed and are available for plantings from the Forest Service Shrub Lab in Provo, Utah (Welch and others, 1985).

General characteristics and uses of these suitable native shrubs is given below.

Sagebrush

Sagebrush plants, Artemisia spp., are valuable browse plants, especially on winter and early spring ranges. Big Sagebrush reigns supreme as a winter forage in terms of digestibility and levels of protein, phosphorus, and carotene (Welch, 1981, 1986). Sage grouse is one of the few wintering species that gain weight during the winter (Beck and Braun, 1978). Sage grouse feed entirely on big sagebrush leaves. These plants contain volatile chemicals that produce the familiar sage odor. These volatile chemicals in sagebrush have been suggested as being inhibitory on the growth of other plants, but proof of this in the field has not been demonstrated. Daubenmire (1970) stresses the complementary nature of sagebrush and herbaceous root systems. In 1975, Daubenmire reported beneficial interaction between sagebrush and grass species. Caldwell (1979) summed up the physiological factors for the success of Artemisia tridentata as including the capacity for photosynthesis at low temperatures, capacity for temperature acclimatization, maintenance of large leaf area throughout the year, sensitive stomatal control of water loss, capacity to remove water from dry soils, and possible presence of secondary compounds which may deter predatory insects and disease.

These characteristics of sagebrush make efficient use of the soil moisture, soil fertility, and solar energy over a long period of years. Sagebrush is one of the most efficient plants for southern Idaho's climate and soils.

Artemisia is associated with the mycorrhizal fungus, Glomus, and it may be a required association for seedling establishment (Marsha Wicklow-Howard, personal communication, 1986; Bethlenfalvay and DaKessian, 1984; Doerr and others, 1984). In large areas denuded of sagebrush by repeated fires and the growth of non-mycorrhizal cheatgrass, this fungus, Glomus, may die off. This may leave no available inoculum in the soil for the re-establishment of sagebrush seedlings. This may be one reason that sagebrush re-establishes in some areas after a fire and not in other areas. Young sagebrush plants grow slowly where competition from other vegetation is severe.

Bitterbrush

Purshia tridentata, a deciduous shrub, was found by Leach (1956) to be heavily browsed in the fall by mule deer. He reported that as the nutrient value dropped with the approach of winter, the deer switch to more nutritious species such as big sagebrush. As a winter forage, bitterbrush is high in palatability and adequate in protein but low in digestibility and in levels of phosphorus and carotene (Welch, 1981, 1986). Its best use as a forage is on summer and fall ranges. However, because of bitterbrush's nitrogen fixing abilities, it should be planted on winter ranges to improve soil fertility. Careful selection of planting sites is very important. It contains several ecotypes that range from prostrate to tree-like forms. Only ecotypes adapted to the

area and soil type should be chosen for plantings. Bitterbrush should only be planted on well-drained sites. Transplanting of bare root bitterbrush seedlings have been successful on the granitic soils of the Boise Front (Carpenter, 1983). Seeding grass and shrub seeds in separate drill rows is a practical method of reducing competition between bitterbrush and perennial grass seedlings (Monsen and Shaw, 1983).

Natural reproduction of bitterbrush has been occurring mainly from rodent caches (Scholten, 1983). Annual biomass production is higher if the shrubs are utilized or cut back, particularly with decadent shrubs. Bitterbrush plantings, however, should be rested from grazing for the first three to five years.

Rabbitbrush

Chrysothamnus subspecies are endemic to Western North America and occur over a wide range of habitats and elevations. They harbor many beneficial, predatory insects, provide late-season nectar, and bear fruit in late fall. This shrub has many species and subspecies.

White rabbitbrush is particularly palatable even in the summer, and the current year's growth is heavily utilized during the winter. Flower heads of all rabbitbrush species are utilized in the fall. Establishment from seed is fair to good, while natural spread from seed is very good. Rabbitbrush is not especially competitive with herbaceous species in most environments, but rather, enhances the growth of herbs (Plummer and others, 1968). Production of crested wheatgrass has increased when growing in association with rubber rabbitbrush (Plummer and others, 1968). Some rabbitbrush species resprout after wildfires thereby naturally rehabilitating an area. Green rabbitbrush is the most widely distributed species in southern Idaho.

Black Sagebrush

Artemisia nova, an evergreen shrub, is exceeded only by big sagebrush in winter nutrient content (Welch, 1981, 1986). This species has ecotypes that are very palatable to mule deer, pronghorn antelope, sage grouse, domestic sheep, goats, and cattle (McArthur and others, 1979). Black sagebrush is an aggressive natural spreader from seed and provides good ground cover for stabilizing soil. It grows on dry, shallow, stony soils often underlain by bedrock or hardpan. This species is more closely associated with salt-desert habitats than any other sagebrush except budsage (Blaisdell and Holmgren, 1984). Black sagebrush may not be as tolerant of soil salinity as winterfat.

Winterfat

Winterfat is remarkably drought resistant and does well in dry sites. It is a highly nutritious winter browse species exceeded only by big and black sagebrush for livestock and big game (Welch, 1981, 1986). Overgrazing has greatly reduced or eliminated winterfat from some areas. It is a good natural increaser, can be broadcast seeded, and is sometimes coated with clay to increase its weight for more even distribution when

broadcasted. However, winterfat seedlings are not competitive with cheatgrass or sandberg bluegrass. Distinct ecotypes of winterfat occur in different soil types.

Spiny hopsage

Spiny hopsage is tolerant of alkaline soils and occurs in a variety of soil types. It is fairly tolerant to grazing, probably due to early dropping of leaves, especially in Idaho. In early spring, it leafs out and at that time, is a valuable forage plant. It also fruits as early as June-July in contrast to most other desert shrubs fruiting in late fall.

Other shrubs

Other shrubs and subshrubs such as Nuttal saltbush, western juniper, matchbrush, serviceberry, rose, honeysuckle (Lonicera tatarica), Kochia, cypress, buckwheats, and skunk bush have been used in plantings of southern Idaho rangelands. Summer and prostrate cypress stay green all summer and may prove helpful in preventing range fires in the area. Many of these other shrubs may do best in optimal sites in southern Idaho rangelands such as draws, north slopes, and other sheltered areas. In drainages, riparian shrubs or gooseberries (Ribes), dogwoods, and Rocky Mountain maples may grow well.

Species Selection Criteria

General guidelines in shrub species selection are:

1. Terrain and soil type must be suitable.
2. Competition must be low enough to assure establishment of seedlings.
3. The species should be part of a mixture of other compatible plant species.
4. Seed availability.
5. Establishment of understory of herbs and grasses that allow shrubs to persist and reproduce.

III. ENHANCING NATURAL REHABILITATION

A. General Principles

In theory, plant succession progresses toward the efficient climax plant community, but succession usually occurs slowly. Each disturbance causes a regression away from climax and a reversal toward the weedy pioneer plant community. Yet, despite all the possible disturbances that may occur, nature can rehabilitate areas and does so without capital expenses. How can this natural rehabilitation process be enhanced?

B. Use of Existing Sites

Often, even after fires, an area will have some refuge sites with surviving shrub species present. These sites can be used as "centers of dispersal." These wild plants are the best suited for the area. They have been selected by the environmental conditions of that site and likely the best genetic ecotypes. Their natural adaptation to the area make them the preferred source for rehabilitation of that area. Therefore, a small investment of time and energy toward these, centers of dispersal, may provide for the highest quality seed possible. These areas can be managed to encourage the growth, vigor, and seed production of these plants. This encouragement may include fertilization, irrigation, reducing competition, or fencing of these plants. Rodriguez and Welch (unpublished data) found that big sagebrush plants protected from heavy browsing (70% or more of current year growth) produced from 30 to 50 times more seed stocks than heavily browsed plants. The seed stocks from the protected plants were two inches longer. Some seeds disperse widely while others such as sagebrush rarely disperse more than 10-20 meters from the parent plant. Once these plants produce seed, the seed can be dispersed naturally or can be collected and sowed in selected sites on a prepared seed bed. This method can be applied at various scales and intensities to suit project needs. "Centers of dispersal" provide for the dissemination of shrubs, forbs, native grasses, cryptogams, mycorrhizal fungi, and other organisms. Natural recovery and spread of shrubs, particularly big sagebrush and rabbitbrush, has occurred in many areas and is commonly relied upon in many rehabilitation projects. Natural spread of big sagebrush has not occurred in some of these semi-arid sites of southern Idaho. Reliance upon natural spread is not a sure technique in these areas when cheatgrass is present (personal communication, Steve Monsen, 1986).

C. Creating Centers of Dispersal

In some areas, there are no existing refuge sites of browse species, but instead of attempting to rehabilitate the entire area,

several small centers of dispersal could be planted. These created centers of dispersal could be transplanted shrubs from nearby areas, bare root stock, containerized stock, or seed. Quarter-acre plots with about 100 plants in the plot is a possible size to rehabilitate 80-100 acres (personal communication, Jacy Gibbs, 1985). Rodent and rabbit control may be required in such sites. Predator perching posts erected in seedlings might be effective in rodent control. Natural dispersal outward from these centers of dispersal can eventually rehabilitate the entire area if cheatgrass is not the dominant cover. This method may be particularly appropriate when only a small supply of seed is available from a special source.

This method of creating centers of dispersal is also very appropriate for improved cultivars of native shrubs. They are in short supply and may require labor-intensive hand planting. Such high quality stock are referred to as "Mother plants." They may be highly palatable, such as Hobbie Creek Sagebrush which requires protection from heavy wildlife grazing in order to produce a large seed supply. In addition, the individual Mother plants that survive in a particular climate and soil type will produce seed which is adapted for that site. To protect these centers of dispersal from recurrent fires, the perimeter could be disc plowed or areas nearby could be planted to fire resistant vegetation (green stripping). The trick is to establish understory that will eliminate cheatgrass yet allow sagebrush to establish again.

Areas adjacent or near these centers of dispersal, could, in later years, be treated to encourage colonization of naturally dispersed seed. Treating the seed bed would eliminate competition. Seeds from the centers of dispersal could be collected and immediately sowed on the surface nearby or raked into the soil. Small seeded sagebrush should be sown on the surface without trying to cover the seed. Seeding should take place during late fall or the first part of December.

IV. SEEDING

- A. Broadcasting. Most of southern Idaho's shrub species are naturally spread by the wind dispersing their seeds. Therefore, many species such as sagebrush may be seeded by broadcasting rather than drilling. Ground or aerial broadcast methods are suitable. Rabbitbrush and sagebrush should be seeded in late fall or during the first part of December just prior to winter snow accumulation. For sagebrush, germination of the seed is best on a disturbed soil surface although seeding can be done on undisturbed bare soil. Do not plant seeds deeper than 1/10" (5 mm). Sagebrush seeding rate has been recommended at 1/2 to one pound Pure Live Seed (PLS) (personal communication, Bruce Welch, 1986). Don't plant sagebrush with a heavy mix of crested wheatgrass as this species is a very strong competitor for the establishment of sagebrush seedlings.

As a rule, the fixed-wing airplane is best for aerial seeding except on small areas. Helicopter application may be more expensive and light seed(s), such as sagebrush, may be pushed out to the side by the downdraft. Plant in the fall for best results (personal communications, R. Stevens and K. Jorgensen, 1985). For sagebrush, plan application just ahead of the first snow accumulation or approximately the first of December (personal communication, Bruce Welch, 1986). Aerial seeding in the winter on top of uncrusted snow has also been successful. Most shrub seeds other than sagebrush need to be covered 1/4" to 1/2" below the soil surface. Therefore, broadcast seeding of these shrubs should include a culti-packer or drag chain following sowing. Winterfat and other light seeds can be best distributed by hydroseeding or coating the seed (Pellant and Reichert, 1984).

- B. Drilling. Rangeland drills can be used for shrub, forbs, and grass seedings. Drill seeding utilizes a minimum amount of seed which is well distributed at controlled depths. However, steep slopes can not be seeded with drills. Also, seeds of various sizes, shapes, and weights may not be evenly distributed. Often a carrier or filler such as rice hulls is added to certain seed for better distribution. Seed rates can often be half those of broadcast seeding. However, operational costs of drilling are greater than in broadcasting. Shrub seed can be placed in separate drill rows from grasses to reduce competition. Crested wheatgrass and other grasses are very strong competitors and will reduce the success of the shrub seeding if not controlled. Planting bare root shrubs into scalped areas within crested wheatgrass stands has been successful. The wheatgrass re-invades the scalp slowly and the incidence of annual weeds such as cheatgrass is minimal.

Plowing furrows in the soil surface to create water storage depressions has proven successful with shrub plantings in central Utah. The size of the furrow and the height of the berm shading the shrub seedling can vary based on the precipitation and the soil type.

Sagebrush seed has been mixed with rice hulls and dispersed with a modified rangeland drill. Mike Pellant of the Boise BLM District suggests bending the metal portion of the seed tube so that the seed does not fall exactly in the furrow but does accumulate in a narrow band on the soil surface. The drag chains should be tied up to prevent covering of the seed. The gap between the seed cup and seed funnel should be closed off to prevent wind from scattering the seed mix before it even enters the seed tubes.

- C. Seed Collecting. As the demand for local ecotypic species increases, commercial sources may become available. In the meantime, seeds will have to be harvested from native sources by collectors. Harvesting is the most important and costly phase of providing seed that is not available commercially. Thus, when wildland stands produce a good seed crop, stockpiles for two or three years use should be obtained. Methods of collecting seed vary according to site conditions and species. Shrub flower stalks can be cut in the late fall (mid-November) prior to their seeds complete maturing, then stored intact until dried and matured. Seeds of most shrubs can be separated from their parent plant by hitting the limbs with a club or stick or by shaking the branches so the seeds fall into containers. Containers can be of various sizes and materials. Plastic five-gallon buckets with a handle (pickle buckets), plastic bags, or canvas hoppers carried by a strap slung over the shoulder are effective. Seeds of rabbitbrush, black sagebrush, and winterfat are best collected by hand stripping into shoulder hoppers. It is important that seeds be collected at the appropriate time of the year (see Table #1). This labor-intensive work may be done with volunteer groups such as big game hunting clubs, Boy Scouts, or conservation organizations. Seed may also be purchased directly from amateur collectors or independents in the local area.

Seed collectors should make sure that seed fill is adequate. They can determine this by cutting seeds sampled at random with a sharp knife or fingernail clippers.

- D. Cleaning Seed. Cleaning seed is an extremely important process because it determines what methods can be used for planting, as well as the success of seasonal storage. With the exception of sagebrush, seeds of most dry-fruited shrubs are readily processed in farm hammermills; these mills should be operated at slow speeds so as to avoid damage to the seeds. Seeds should be completely dry before hammering. Hammermilling reduces bulk by breaking off plumes and breaking up extraneous material so that the seeds can at least be dried without further processing. For final cleaning, the seed is put through an ordinary fanning mill properly fitted with screens. Two-screen mills are quite satisfactory.

Bitterbrush and similar seeds can be cleaned to satisfactory purity by using a dewinger, which rapidly removes and segregates husks and trash from the seed in one operation. For best results, a piece of

corded rubber belting should be wrapped over the brush rollers. If uncleaned seeds are heavily laden with trash, they must be run through the unit twice; but the operation is rapid, and several hundred pounds of seed can be treated within two hours. Bitterbrush seed can be cleaned up more efficiently if the seed is run through the fanning mill prior to dewinging process (personal communication, Steve Monsen, 1986).

In preparing ripe berries, the cleaner should remove the pulp soon after collection; but if this is not possible, berries should be spread into a thin layer to prevent overheating and consequent damage to the seeds. Seeds can be extracted by macerating the pulp in a Dybvig seed cleaner and floating the pulp and empty hulls off in water. The remaining debris can be removed readily by a fanning mill after the seed is dry. Seeds of most berries can easily be cleaned up to 90% purity.

Some modifications in processing and cleaning are necessary for seeds of some shrubs and forbs. Hard seed coats need scarification to improve germination, and fungicides and rodent deterrents are now being applied with special equipment at commercial seed houses.

- E. Seed Storage. Most seeds can be stored for two to three years in a dry, cool, ventilated, rodent-proof container or warehouse. However, rubber rabbitbrush and winterfat seeds lose considerable viability after two years' storage. Sagebrush seed retains nearly 50% of its rate of germination for up to four to five years in proper storage (Stevens and others, 1981). Many seeds will germinate better if given a cold treatment. This cold treatment is called stratification. It is best done with moistened seeds kept a few degrees above freezing for two to four weeks. If seeds such as bitterbrush are stratified, they will have a faster and higher germination rate. Fall-planted seeds are subjected to winter moisture and temperatures that satisfies the stratification requirements.

V. SEED AND PLANT SOURCES

Areas to be planted should be inventoried to determine soil type and present vegetative conditions. Based on this inventory, the selection of a species planting mixture should be made. Table #1 can be used to determine suitable shrub species. The season of planting should be determined based on your species selection. To ensure seeds of the proper plant ecotype, acquisition of seed should be from plants growing in similar habitat types within the local area. Plantings may consist of (1) bareroot, (2) containerized, or (3) wildings.

Seeds and plants may be obtained commercially, yet local ecotypes are rarely available. Much of the failure in the past with seeding shrubs has been blamed on the seed source not being adapted to the local area or soil type (Monsen and McArthur, 1984). Therefore, establishing seed collection sites, seed gardens, and direct transplants may be necessary.

- A. Seed Collection Sites. Designating seed collection sites, which are areas of good quality plants suitable for planting in similar soil types within the local region, would facilitate both commercial enterprises and government contracting. Seeds used for reseeded basalt-derived loams in the Snake River Plain of Idaho would be obtained from one of several seed collection sites designated in the Snake River Plain. This suggests that areas of public or private land suitable as seed collection sites be designated, posted, and managed accordingly. For example, the BLM could designate specific sites in the Bennett Hills area as a collection site for Wyoming sagebrush and a site east of Kuna, Idaho, for rubber rabbitbrush. These seeds could be used throughout the Snake River Plain, yet would not be acceptable for projects in eastern Montana or Arizona. These sites could be managed as status quo, or could be fenced off from browsing, or fertilized, or weeded, or mechanically thinned to increase seed set. Seed set will increase with even a single irrigation during the dry season (personal communication, Bruce Welch, 1986). Competition from weeds would be decreased using approved herbicides, plowing, disking, mowing, or rotobating every other 6-10 foot strip of vegetation. This also releases soil moisture to the remaining shrubs resulting in greater seed production. Thus, plowing strips in dry land sites can stimulate seed production. This management could be done by the BLM, by cooperative agreement, or leased to a commercial company. Areas managed intensively would be seed gardens. Presently, there are shrub seed gardens operated similar to nurseries and these currently provide a good source of seed for some species. They are normally fertilized and irrigated.
- B. Nursery Stock. Nurseries can also provide bare root stock and containerized stock. Bare root shrub stock should be one or more years old and should be planted as soon as frost leaves the soil in

late winter or early spring. Containerized stock of arid shrub species should be grown in soil rather than the usual peat moss/vermiculite medium (Carpenter, 1983). If a peat medium is used, cover it with at least 1/2" of native soil to prevent the peat medium acting as a wick and drying out the young shrub. Use of containerized stock should be considered for areas depleted for several years and that may lack the proper mycorrhizal fungi in the soil. Under these circumstances, the containerized stock should be inoculated with compatible fungi. Container seedlings, though initially expensive, give a product in a short time and often have improved survival and growth rates (Landis and Simonich, 1984). Shaw and others (1984) found that four-wing saltbush planted in arid rangelands of southern Idaho readily established without irrigation and grew rapidly. Sagebrush, rabbitbrush, and bitterbrush also survive well without irrigation (personal communication, Steve Monsen, 1986). Transplanted stock here refers to wild plants being moved from one site to another. Many of the arid shrubs in southern Idaho transplant easily and successfully. Sagebrush, four-wing saltbush, rabbitbrush, and bitterbrush are some of the species known to survive transplanting well (Plummer and others, 1968). Such shrubs can be dug up from similar, nearby sites and replanted into the middle of large, burned-over areas. This transplanted shrub and its surrounding soil would contain the necessary mycorrhizal fungi and be well adapted for the site. This is a labor-intensive method but involves little capital costs. It enables the establishment of species that will produce seed for natural increase. Transplanting should take place in late winter or early spring when the frost has left the soil. Prospective plant material should be marked early to assure ease of relocating the sites and an abundance of plants for the project.

Wild transplants or nursery stock could be done by mechanical scalping and planting or by hand. Hand planting should always include "scalping," which is the process of removing the vegetation from the area to be planted. For most shrubs, the scalp should be a minimum of two square feet. Mechanical transplanting is a rapid means of planting large numbers of shrub seedlings during short periods of favorable soil moisture (Shaw and Monsen, 1984). Mechanical plantings could utilize modified tree planting-type equipment, such as forestland tree transplanters or corn planters (Shaw and Monsen, 1984). These transplants are best replanted soon after being dug up, but could be stored in a cold room for a period of time. To enhance survival, dig a basin about one foot in diameter with the plant at the bottom of the basin which serves as a water catchment.

Firming the soil around the roots is the most critical step in the planting process (Carpenter, 1983). If the soil is not compacted tightly against the roots, air spaces will remain, causing moisture stress upon the plant. Another major reason for seedling mortality in bitterbrush is improper planting depth (Carpenter, 1983). It is better to plant a bitterbrush seedling too deep than too shallow.

VI. MANAGEMENT GUIDELINES

Once winter range seedings have taken place, special follow-up management is necessary. Shrubs often need more than the usual two years of rest from grazing after seeding. In general, shrubs need to be rested until they start to reproduce. Bitterbrush seedlings may need four to five years of establishment before a stand can be grazed, while sagebrush can be grazed after only three to four years of rest. Table 2 summarizes the suggested period of rest after planting for various browse species.

Proper grazing management is necessary in order to retain mixed shrubstands rather than allowing successional shifts or grazing patterns that lead to the loss of the more palatable shrubs (Jensen and others, 1972).

A. Sagebrush

Big Sagebrush, Artemesia tridentata, plants usually begin reproduction at an age of three to four years (Tisdale and Hironaka, 1981). Cook and Stoddart (1960) found that A. tridentata can tolerate about 60% use during winter, but allowable use during late spring was only 35%. Pearson (1965) found severe damage from one season of 100% use. Wright (1970) found that an 80% use rate was most harmful in midsummer (July) when carbohydrate reserves were lowest, and least harmful during the late summer, fall, and winter months (Tisdale and Hironaka, 1981).

B. Bitterbrush

The tolerance of antelope bitterbrush to clipping or grazing is similar to that of associated shrubs in the sagebrush-grass region. Garrison (1953) found that plants on favored sites produced maximum foliage when clipped in the fall at a rate of 75% of the annual growth, but failed to make normal growth in height. A safe rate of utilization was estimated at about 60% on these sites and only 50% on poorer sites. Trlica and others (1977) reported slow recovery after three defoliations of 90% (Tisdale and Hironaka, 1981).

C. Rabbitbrush

Rabbitbrush responds to continued harvesting in much the same way as other shrubs of the sagebrush region. Garrison (1953) found that Rubber rabbitbrush produced well when 73% of the annual growth was clipped during autumn for four years but crown cover declined. It appeared that 50% would be a safe rate in the fall and winter seasons (Tisdale and Hironaka, 1981).

D. Winterfat

Winterfat responds well to good management. Grazing during the winter dormant period has little effect on plant vigor. Moderate, early, and midwinter grazing stabilizes forage production and maintains good growth, vigor, and seed production. Anything more than light grazing (25% removal of current growth) during the active growing season will result in depleted plant vigor (Stevens and others, 1977).

TABLE 1.

Shrubs Suitable for Planting on Rangelands in Southern Idaho

Common Name	Soil Type	Elevation	Characteristics	Palatability	Relative Planting Rate Pure Live Seed lbs/acre
Wyoming Big Sagebrush (<u>Artemisia tridentata</u> ssp. <u>Wyomingensis</u>)	Shallow - moderately deep	Low	Less than a meter tall; varies by ecotype	Moderate-High	1/2
Great Basin Big Sagebrush (<u>Artemisia triden-</u> <u>tata</u> ssp. <u>triden-</u> <u>tata</u>)	Deep well-drained soil	Low-Mid	Tall sagebrush of drainage ways	Low	1/2
Mt. Big Sagebrush (<u>Artemisia triden-</u> <u>tata</u> ssp. <u>vaseyana</u>)	Deep well-drained soil; cool soil sites (frigid)	Mid-High	Flat topped appearance tends to form dense stands	Fair-High	1/2
<u>Cultivars of Big Sagebrush</u>					
Hobble Creek Big Sagebrush (<u>Artemisia triden-</u> <u>tata</u> ssp. <u>vaseyana</u> cultivar Hobble Creek)	Deep well-drained precipitation 14+ inches	Low-Mid	Highly palatable; more drought resistant than regular Mt. Big Sagebrush	High	1/2

Common Name	Soil Type	Elevation	Characteristics	Palatability	Relative Planting Rate Pure Live Seed lbs/acre
Low Sagebrush (<u>Artemisia arbuscula</u>)	Dry cold sites with shallow hard pan	Low-High	Low growing; often in wind-swept sites	Low	1/2
Silver Sagebrush (<u>Artemisia cana</u>)	Cold-poorly drained soil	Mid-High	Poorly drained playas, wet meadows, and layers; restricted distribution in Idaho	Moderate	1/2
Black Sagebrush (<u>Artemisia nova</u>)	Dry, shallow calcareous gravelly soils in cold sites	Low-Mid	Low growing in rocky dry sites; often wind blown; highly palatable	High	1.0
Alkali Sagebrush (<u>Artemisia longiloba</u>)	Dry cold sites with shallow clay pan	Low-High	Often in drainage ways	Low	1/2
Three Tip Sagebrush (<u>Artemisia tripartita</u>)	Moderately deep cold sites	Mid	May sprout after fire. Variable palatability between populations	Low	1/2
Fringed Sagebrush (<u>Artemisia frigida</u>)	Coarse shallow soils in cold sites, limited distribution in Idaho	Low-High	Mat forming subshrub; deep perennial taproot; most palatable in late fall and winter. Good pioneer sites on harsh sites. Transplants easily.	Seasonably Moderate	0.2-0.3

Common Name	Soil Type	Elevation	Characteristics	Palatability	Relative Planting Rate Pure Live Seed lbs/acre
Budsage (<u>Artemisia spinescens</u>)	Dry saline flats shallow soil	Low	Low, spinescent aromatic deciduous shrub; starts spring growth in Feb-March; associated with shad- scale; sensitive to heavy grazing. Difficult to seed.	Highly palatable in late winter & early spring; only fruits in June	1/4-1/2
Bittrbrush (<u>Purshia tridentata</u>)	Well drained deep soils. Good in coarse soils.	Low-High	Several growth forms and ecotypes	High	1/2-3
Fourwing Saltbrush (<u>Atriplex canescens</u>)	Various soil types; low salt tolerant	Low	Tolerance to hev grazing; monocious plants propagates by stem cuttings (McArthur and others, 1984)	Moderate	1-3 Dewinged seed
Winterfat (<u>Eurotia lanata</u>)	Well drained, deep- very deep soils	Low	Several ecotypes; fruit ripens Sept.-Nov.	High	1-3
Green Rubber Rabbitbrush (<u>Chrysothamnus nauseosus</u> ssp. <u>consimulus</u>)	Shallow-moderately drained soil; hot arid sites	Low	Flowers are palatable manage the area and season of use in such a way so not to greatly increase shrub cover	Low	1/2

Common Name	Soil Type	Elevation	Characteristics	Palatability	Relative Planting Rate Pure Live Seed lbs/acre
White Rabbitbrush (<u>Chrysothamnus</u> <u>nauseosus</u> ssp. <u>hololeucus</u>)	Deep well-drained soil	Low-High	Whole plant is palatable especially the flowers and fruit	Seasonally Moderate-High	1/2-1/0
Douglas Rabbitbrush (<u>Chrysothamnus</u> <u>viscidiflorus</u>)	Dry sites; variable soils	Low-High	Glabrous sems; several ecotypes; most palatable	Seasonally Moderate-High	1/2
Hairy Low Rabbitbrush (<u>Chrysothamnus</u> <u>viscidiflorus</u> ssp. <u>puberulus</u>)	Harsh, poorly developed and dis- turbed soils in in lower elevations	Low	Small shrub	Low	1/2
Prostrate summer Cypress (<u>Kochia</u> <u>prostrata</u>)	Alkaline	Low	Prostrate subshrub from Asia; seeds need cold treatment; spreads well	High	4-5
Summer Cypress (<u>Kochia americana</u>)	Fine textured, low permeability, alkaline	Low-Mid	Small subshrub root sprouting; seeds need cold treatment	Fair	4
Spiny Hopsage (<u>Grayia spinosa</u>)	Alkaline soil	Low	Deciduous shrub; little forage value in winer, but greens up early spring; fruits June-July	High in spring	1/2

Common Name	Soil Type	Elevation	Characteristics	Palatability	Relative Planting Rate Pure Live Seed lbs/acre
Nuttal Saltbush (<u>Atriplex nuttallii</u>)	Alkaline soil	Low	Tolerant of saline soils	Fair-Good	1-3
Western Juniper (<u>Juniperus occidentalis</u>)	Various soil types	Mid-High	Several ecotypes increasing over much of its range	Low	---
Matchbrush (Snake Weed) (<u>Gutierrezia</u>)	Grows in wide range of soil types	Low-Mid	Many ecotypes. Increases with range deterioration. Highly flammable; poor species for palatability but will grow in harsh sites	Low	---

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TABLE 2

Suggested period of rest from grazing after seeding for selected shrub species in Southern Idaho.

2 Years	3 Years	4 Years
Rabbitbrush Summer Cypress	Sagebrush Winterfat Juniper Spiny Hopsage	Bitterbrush Four Wing Saltbush Nuttal Saltbush

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